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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication
of
Communication
Apparatus

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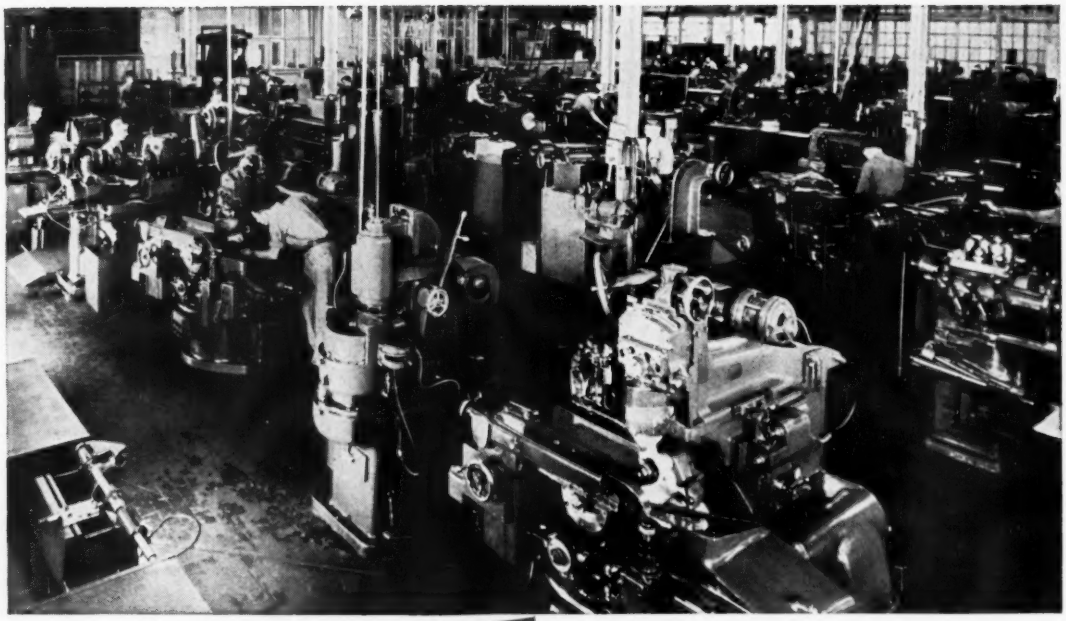

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Lubrication of Communication Apparatus*

WHEN communications involved the smoke signals of the American Indians, the drums of the African Jungle and later the "express" as typified by our own colorful pony express, there was no mechanical equipment required. Manpower cut wood or collected buffalo chips for the fire smoke, manpower beat the drums, horsepower carried the "express."

About a hundred years ago, the scene changed. The railroads were beginning to move faster than the pony, the steamboat was replacing the sailing packet in carrying messages over oceans and up and down the waterways. Then a man named Morse came along with the idea of using that mysterious something: — electricity. He developed a code of dots and dashes, then he transmitted this code from point to point over electric wires strung on poles or trees. It seemed fantastic. So much so that many jokes and anecdotes are told about the so-called power of the wires, i.e., the old lady near Boston who hung her husband's rubbers on a low hanging wire when it rained so they would be sent to Boston for him to wear back home. Later Alexander Graham Bell made it possible to transmit speech by wire.

As the idea was accepted, quite naturally the machinery necessary for faster, better and more distant transmission developed. Basically, it is dependent upon electricity—lots of it, although the amount of power to operate a single modern telephone is infinitesimal. Electricity in turn requires generating equipment, fuel combustion for conversion of energy, pumps, blowers and fans. Today, communication by telephone, telegraph, and wireless involves one of the most overall extensive users of power.

THIS article deals with lubrication of the operational apparatus required in telephone, telegraph, and teletypewriter communication work. This apparatus involves intricate mechanisms which must be maintained in precise adjustment.

Effective lubrication increases the efficiency of telephone service; prolongs the life of these intricate precision mechanisms; and enables the maintenance people also to work with a smile.

Cost of lubricants for these mechanisms is virtually negligible as compared with most other industries, but cost of maintenance in case of faulty lubrication can amount to a considerable proportion of the cost of operation.

THE PART PLAYED BY LUBRICATION

It is interesting to see where petroleum fits into this picture. The development of automatic switching systems played an important part in the expansion of telephone service. In these systems manipulation of a dial obtains the subscriber his number, the operation of intricate switching mechanisms in a central office substituting for the telephone operator. Effective lubrication of these mechanisms assures more efficient telephone serv-

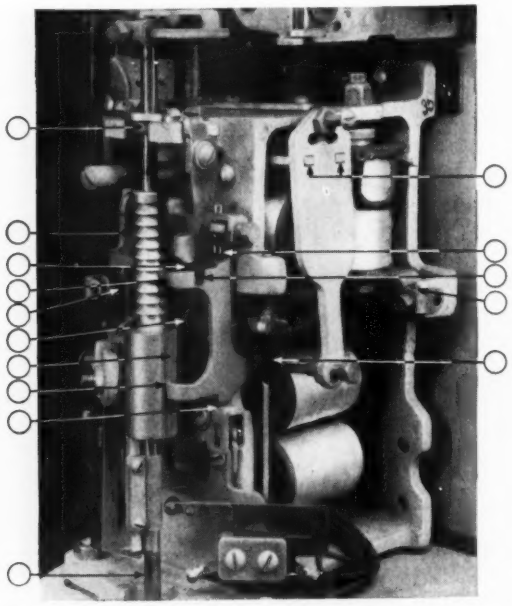
**This article was prepared in cooperation with Bell Telephone Laboratories which also supplied the illustrations.*

ice; thus lubrication has become more and more important in the telephone and telegraph industries as the use of automatic systems has expanded.

The ideal would be to design so that there would be no need for lubrication at all. This objective is in reach today by the use of electronic switching devices, but it is still impractical to plan automatic central offices without moving parts.

Among the specific mechanisms which require lubrication in the telephone system are automatic switching mechanisms, motors, sliding contacts, dial mechanisms, coin collectors, teletypewriters, etc.

In order for lubrication to be successful, it is necessary to study (1) the nature of the lubricants involved, (2) the manner of application, (3) their ability to remain where they belong, (4) the extent to which they form a visible film, (5) their ability to prevent corrosion.



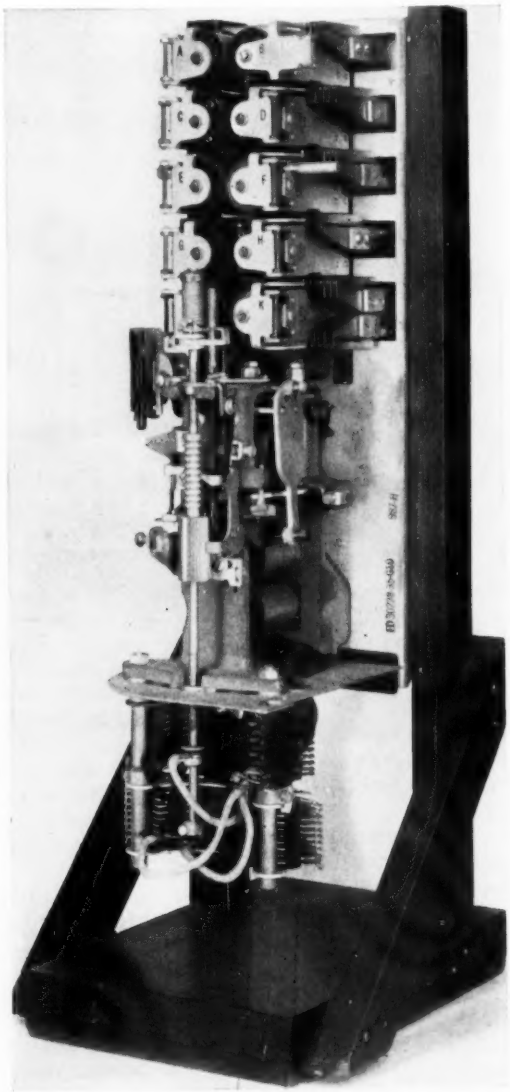


Figure 1—(Above) Showing the many parts of a step-by-step switch which require periodic lubrication by hand with a graphite-light oil lubricant.

(Right) Showing a complete step-by-step switch assembly.

"MUSTS" for the Lubricant

To assure that the various mechanisms are properly lubricated the lubricant must:

1. Stay on the parts which require lubrication. Spreading or creeping is very objectionable because lubricant on parts not requiring lubrication can affect the synchronysm of the entire mechanism or can seriously impair electrical operation.
2. Have a high degree of stability, for it must not oxidize or gum. On intermittent service parts gumming would cause parts to stick.
3. Be compatible with insulating materials with which the oil may come in contact.
4. Have high degree of oiliness since most of the bearing surfaces are operated under boundary conditions.

In addition to the above, dependent upon the conditions of usage, the lubricant also must have the following properties:

1. Prevent the formation of oxidation or tarnish films on the rubbing surfaces, e.g., in contact lubrication.

2. Form a visible film so that the assembly shop personnel or the maintenance people can see where the oil is. This matter of visibility is important as it promotes more care in lubrication and forestalls over-lubrication which can be as bad or worse than too little oil.
3. Have high viscosity index and low pour point when used on equipment in unattended offices or in exposed phone booths.

Solid Lubricants

Since prevention of oil creepage and gumming is of primary importance in lubricating many communication mechanisms, solid or semi-solid lubricants are used whenever possible.

A multi-purpose lubricant in this class is a wax-petrolatum compound applied from solution in an organic solvent. This is used for the lubrication of interrupter cams, which may rub against another metal or against an abrasive non-metal such as phenol fibre, phenol fabric, or hard rubber. It is also used for the teeth of fibre gears, for door hinges in telephone booths, and for a variety of other purposes.

A highly graphited finish has also proved useful as a solid lubricant. It is used for preventing wear on the rubbing surfaces of springs in the cross bar switching system and for lubricating part of the governor mechanism in a special type of dial used by linemen.

Graphite is also the effective lubricant in graph-alloy bearings which are used in the panel switching system for vertical shafts where prevention of oil creepage onto contact surfaces is important.

SWITCHES

In machine switching offices the connection between the calling subscriber dial and the called subscriber is completed through very intricate switching mechanisms in the central offices which are maintained by skilled maintenance men and operated at temperatures from 50°F. to 120°F. In cases where there are only a small number of subscribers involved, the switching offices may be unattended and subjected to lower temperatures.

Three types of automatic or mechanical switching mechanisms have been developed by telephone engineers, i.e.:

1. The step-by-step
2. The panel
3. The cross-bar

The step-by-step switch

This was the first development; today there are several million step-by-step switches in service. To lubricate one requires on an average of five minutes. No wonder ways and means of extending the time between lubrication periods were studied. Use of graphite as a visibility and lubricity adjunct was a feature of the investigation. That it was successful is indicated by the fact that today these switches

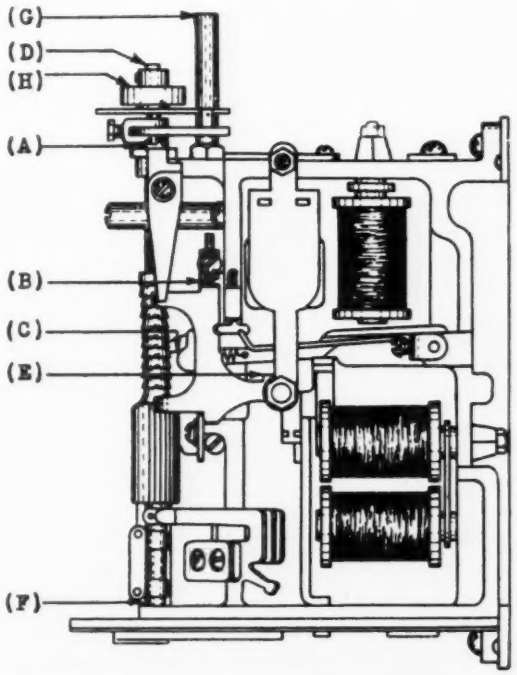


Figure 2—Points of lubrication on a step-by-step switch. A and F are the upper and lower shaft bearings; B is the double dog bearing pin; C is the vertical pawl between the pawl bearing lugs and the bearing collar; D is the top of the shaft between the shaft and the spring cup; E is the tip of the double dog release tooth; G is the normal post above the surfaces which may be engaged by the shaft spring bracket; H is the cup spring provided with an oil hole.

are re-lubricated every two years, instead of semi-annually as was the original practice.

There are over a dozen small parts in such a switch mechanism which must be lubricated (see Figure 1). Predominating are the main vertical steel shafts which slide up and down through nickel-silver bushings or guide bearings each time a connection must be made; their rise is actuated by electric power; however, their drop or return to zero after the call is completed is by gravity. (See Figures 1 and 2, pages 110 and 111.)

Obviously, these shafts must be coated with a durable film of lubricant, likewise their guides. This lubricant must not gum or oxidize nor become too viscous at low temperatures. If this occurs, the shafts won't drop rapidly enough or they might even stick in their guide bearings — then there is a job for the serviceman and the cost of mainte-

nance goes up. It was on these shafts that the lubrication engineers found controlled brush-type lubrication to be so effective. (See Figure 10, page 116, with description of lubricating devices.)

In addition to the two main shafts there are two ratchets, one vertical and one rotary, which are also brush lubricated; also, two pawls and a number of other very small bearings.

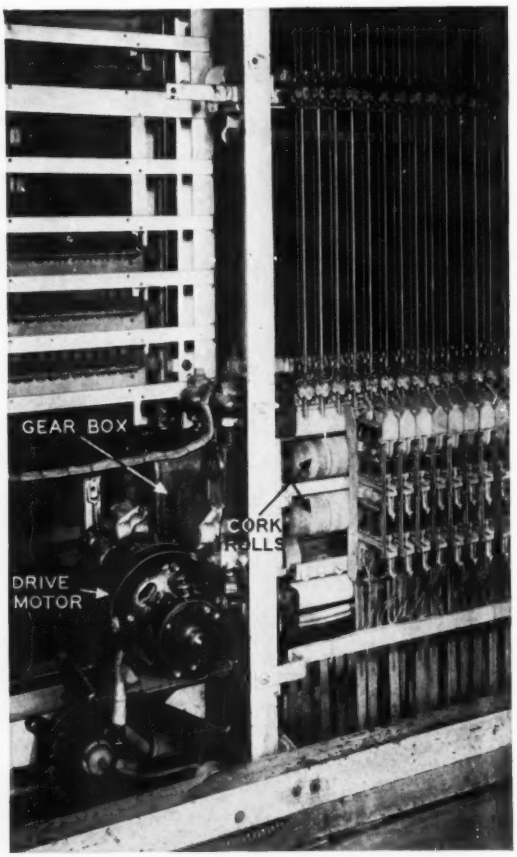


Figure 3—Panel machine switching drive mechanism showing section of bank and the cork rollers, gear box and drive motor.

The Panel Switch

This was a later development. Panel switching is adaptable to densely congested areas where flexibility of trunking is required — for example, in the New York City financial district.

The panel system has fewer small parts to be lubricated than the step-by-step system. (See Figure 3, page 112.)

The lubrication engineer is chiefly concerned with the motor-gear sets, one on each end of every frame, which drive the cork rollers. These cork rollers raise the panel brush racks up and down as a circuit is being made or completed. As this motion depends on friction between the surfaces of the cork rollers and the metal surfaces of the racks, anything which would promote slippage would affect the time required to complete the circuit. Lubricant on the cork roller surfaces would have this effect. That is why motor-gear set lubrication has been given so much careful study to keep lubricant from leaking out of the gear boxes and onto the cork rollers. Treatment of the edges of the cork surfaces of these rollers to prevent creepage of oil has also been studied. (See Figure 4, page 112.)

Panel Bank Lubrication

Lubrication of panel bank contacts is unique. The primary purpose is to prevent microphonic

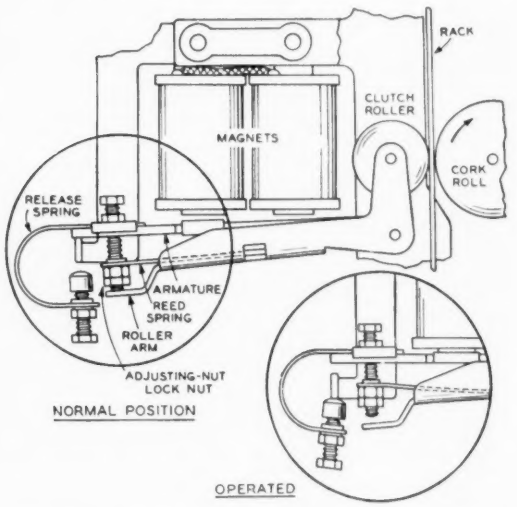


Figure 4—Details of a panel clutch showing the clutch roller and cork roll.

noise resulting from the development of high electrical resistance. The latter is due to formation of insulating films on the contact surfaces. These films may be formed in three ways.

1. By oxidation or tarnishing of the metal by the atmosphere.
2. By oxidation caused by frictional heat.
3. By contamination of dust or dirt from the air.

The function of the lubricant is to prevent the formation of these films by slowing diffusion of tarnishing gases to the surface, by reducing frictional oxidation, and by dispersing atmospheric dust and wear products.

The lubricant must be semi-solid since no re

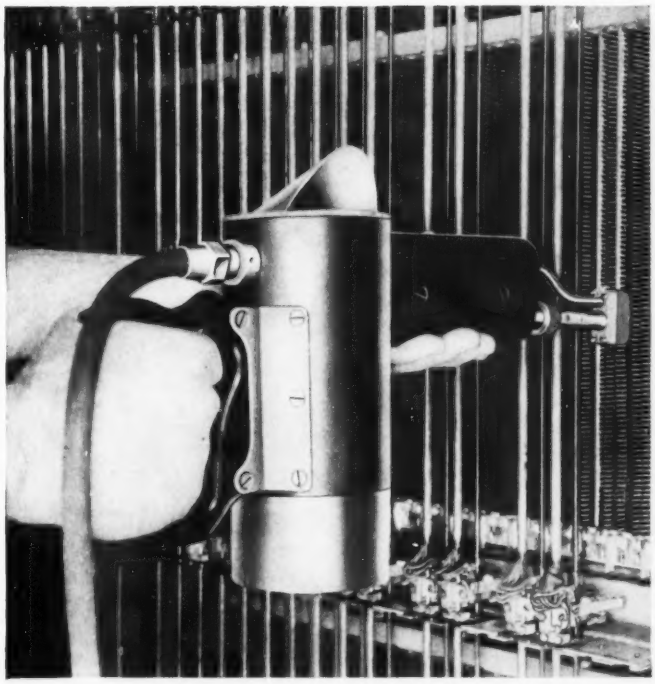


Figure 5—Showing part of a panel bank with the suction lubricant remover in use.

taining device is provided. Use of additives in a petrolatum base serves the purpose to good advantage.

This preparation is applied by a specially designed pressure applicator. As old lubricant must be removed from the contacts before re-lubrication, a specially designed vacuum or suction device has also been perfected. (See Figure 5, page 113.) The applicator (as shown in Figure 6, page 113) is so built that as it is moved up or down the contacts, the turning of a set of gears in the nozzle emits just the right amount of lubricant for the surfaces to be coated. One application of this nature gives the protection and low noise level desired for a period of two years.

The Cross-bar Switch

The cross-bar switch is simpler and more economical as to lubrication maintenance. No sliding contacts are involved, as in step-by-step and panel types. No tarnish of the contact faces occurs since they are made of precious metal.

THE DIAL MECHANISM

Probably the most important function of a dial lubricant, and indeed of lubricant in many other telephone mechanisms, is to run the parts in to smooth operation. When the intricate parts are properly lubricated, they will function satisfactorily for hundreds of thousands of operations without further lubrication.

Figure 7, page 114, shows the dial and the parts of its mechanism such as the governor gears, pulse pawl shafts and retaining bearings; these are all lubricated on the bench at the time of assembly. (The lubrication chart is shown as Figure 8, page 114.)

The dial governor is a most critical part. It controls the return of the dial to zero before the following letter or number can be dialed. A normal running speed of 10 pulses per second is required for the dial to transmit its electrical pulses to the switching mechanism. So don't try to hurry a dial on

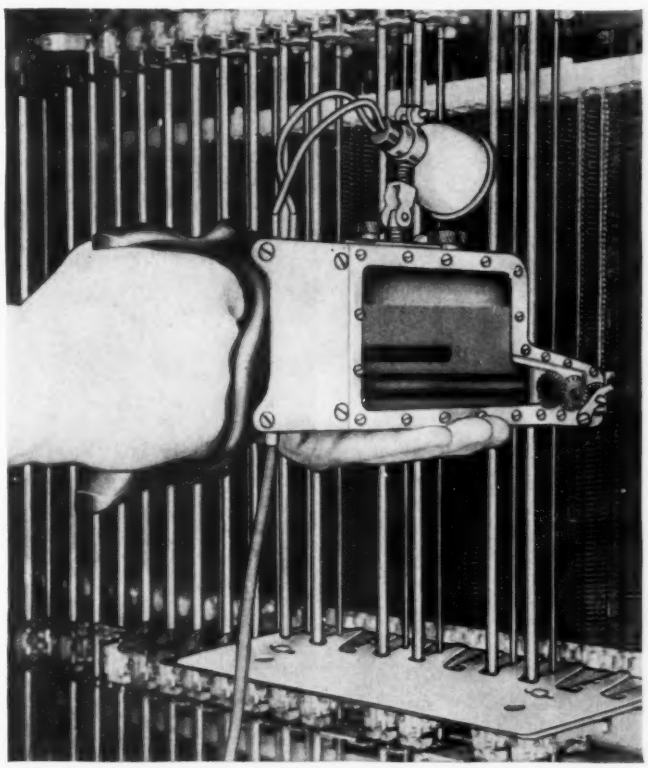


Figure 6—The lubricant applicator in position for applying lubricant to a panel bank. Interior construction of the applicator can be seen through the transparent side plate.

Figure 7—Showing the operating mechanisms in a dial.

its back-swing. It returns at a controlled rate.

The lubricant must not creep or spread to the governor mechanism as this would speed up the dial. This would shorten the electrical pulses being sent out by the dial to such an extent that the central office switching equipment might fail to operate properly.

Creepage is a function of viscosity. Light oils of low viscosity creep or spread more than heavier ones. To cut down creepage, the trend is to go to heavier or more viscous oils. However, careful selection of the lubricant is necessary to insure that the service of the dials in exposed locations will not be impaired at low temperatures. In some locations temperatures as low as −40°F. may be encountered; the viscosity of the oil at the low temperature must be such as not to interfere with free operation of the moving parts.

TELETYPEWRITERS

There is an exceptionally large number of bearing surfaces requiring lubrication in the teletypewriter as can be seen from the view in Figure 9, page 115. Proper lubrication of the intermittent slipping clutches, which require very close friction tolerances, is very important. The oil for the lubrication of these clutches is fed through felt wicks and must have exceptional stability at high tem-

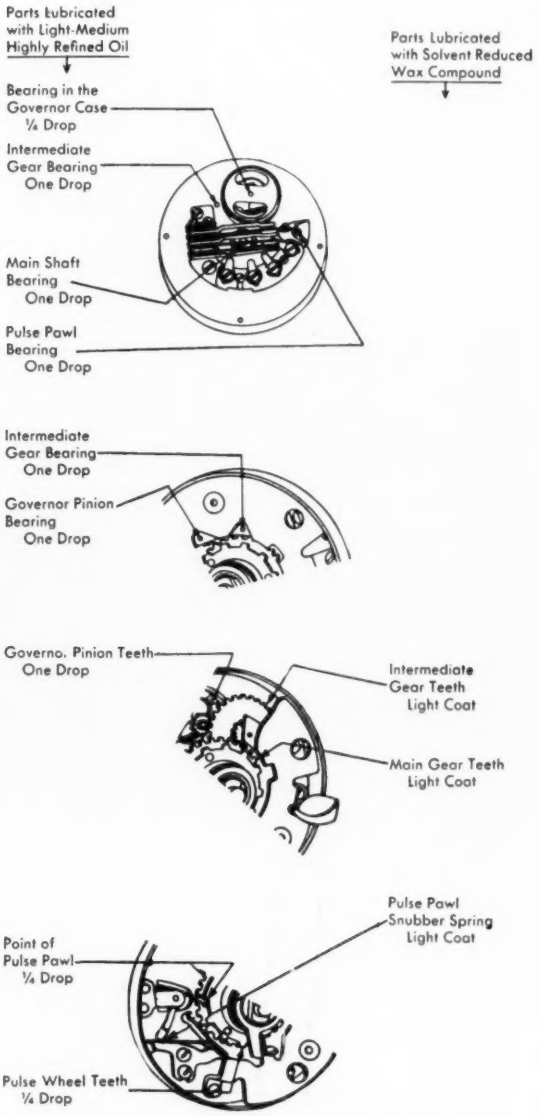

Parts Lubricated with Light-Medium Highly Refined Oil
Parts Lubricated with Solvent Reduced Wax Compound
Bearing in the Governor Case ¼ Drop
Intermediate Gear Bearing One Drop
Main Shaft Bearing One Drop
Pulse Pawl Bearing One Drop
Intermediate Gear Bearing One Drop
Governor Pinion Bearing One Drop
Governo. Pinion Teeth One Drop
Intermediate Gear Teeth Light Coat
Main Gear Teeth Light Coat
Pulse Pawl Snubber Spring Light Coat
Point of Pulse Pawl ¼ Drop
Pulse Wheel Teeth ¼ Drop

Figure 8—Lubrication Chart for a dial mechanism.

perature. The grease for the hot running ball bearings of the motor must also be stable at high temperature.

COIN COLLECTORS

The coin collector mechanism is subject to a wide variety of temperature and dust conditions in telephone booths. They require relatively dry lubricants which will assure minimum friction during intermittent service without contaminating the money.

tion engine driven motor generator sets for emergency service when electric power fails. These sets must function instantaneously when needed. They operate in a wide variety of ambient temperatures and thus require lubricants chosen to suit these conditions. Since the operation is intermittent the lubricants must be stable over long idle periods.

LUBRICATION PROCEDURE

The tools of lubrication play an important part

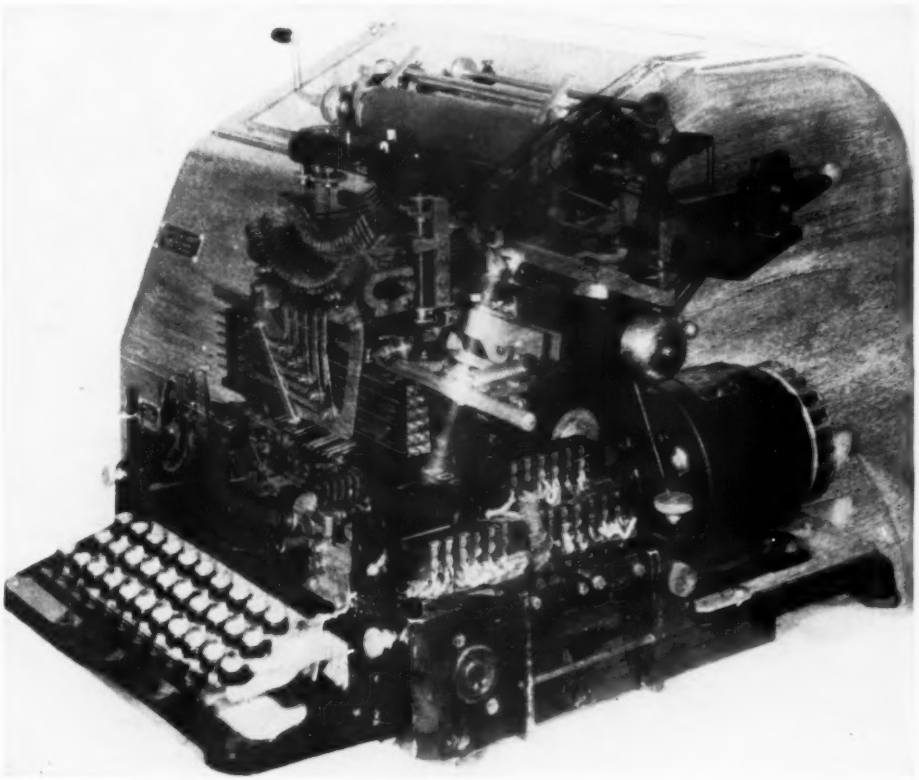


Figure 9—Phantom view of a No. 15 D. D. Teletypewriter.

MOTORS AND MOTOR-GENERATORS

Motor power is quite logically very widely used in communications. Motors are used for five basic operations, i.e., switching, storage battery charging, generation of ringing current, air circulation and emergency engine generator sets. The motor-gear set required for panel switching has already been mentioned. The larger size motor-generator sets which are used for charging storage batteries may range up to 115 h.p. capacity. Within this same capacity range are the motors which drive the blowers on air-circulating systems in central offices. In addition, there are the internal combus-

in both initial lubrication and re-lubrication of communications apparatus. Initial lubrication is generally taken care of on the assembly bench. Later, when re-lubrication is necessary (according to the established time schedule), the mechanisms may be either serviced on the maintenance bench or in place.

Dial mechanisms, as already stated, are lubricated on the bench. The time interval between re-lubrication periods for a dial is indeterminate. Under normal conditions, the initial lubrication may suffice for years. Whenever a dial is taken apart for repair, however, its parts are re-lubricated during re-assembly.

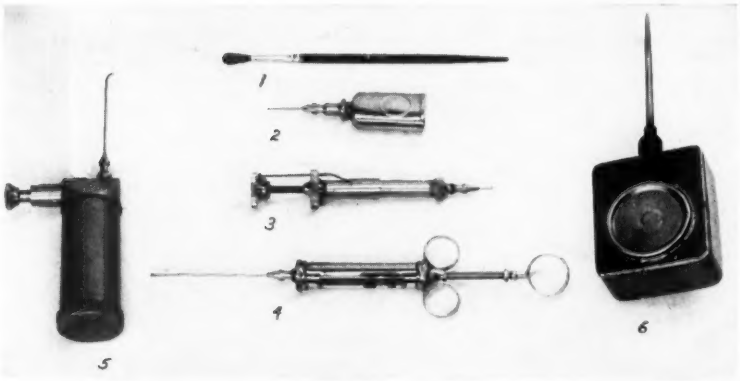


Figure 10—Tools for applying oil.

1—No. 4 Artist Show Card Brush. Tool for applying controlled quantities of lubricant to rubbing surfaces and small areas of friction.

2—Oil Can—Tool for discharging one drop of oil per operation.

3—Oil Gun—Special oiling tool to discharge one drop of oil per notch.

4—Oil Syringe—Tool for applying controlled quantities of oil through small orifices.

5—Oil Gun—Tool for discharging heavy cylinder oil in definite limited quantities. Its construction will also permit the use of lighter oils.

6—Oil Can—Tool for discharging controlled quantities of oil, from one to 15 drops depending upon the pressure applied to the bellows.

Application of Lubricants

Lubricants are applied to small mechanisms by hand, in a manner and with devices which control, very accurately, the amount of lubricant being applied. (See Figures 10 and 11, page 116.)

A working schedule for application of lubricants is definitely advantageous. Using specified designs of pressure oil cans or brushes of a certain size and type, this schedule insures the application of just the right amount of lubricant to each part. Some parts are oiled by drop, from suitable oil cans, others such as the shafts of a step-by-step switching system are oiled by brush, the brush being dipped just so far into the oil and then wiped on one side.

Another method is to use a wire for directing a scant drop of oil to such parts as the steel bushings which carry the steel pins of various dial and teletypewriter mechanisms.

Switchboard mechanisms, on the contrary, are lubricated in place. Their parts move far more frequently than a dial mechanism hence lubrication-maintenance is required. In a limited number of cases the schedule may call for monthly re-lubrication; in most cases, however, the parts are lubricated semi-annually or even less frequently.

The detriments of over-lubrication have already been mentioned; obviously the purpose is to forestall as far as possible that natural human tendency to apply just a little more oil to be on the safe side.

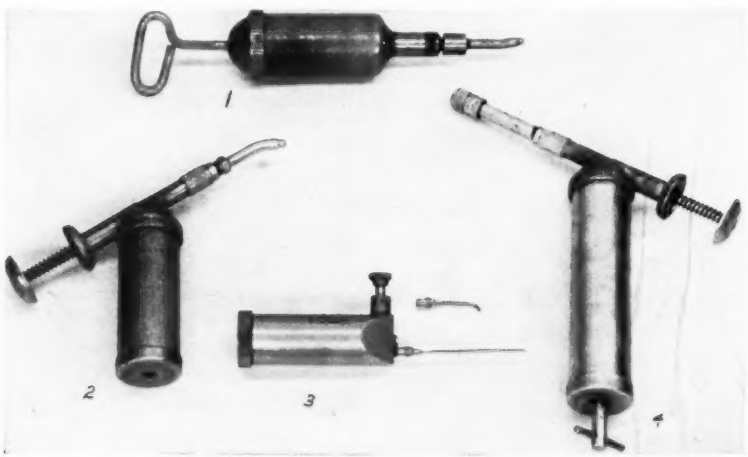


Figure 11—Tools for applying grease.

1—Grease Gun—Tool for applying grease to fittings.

2—Grease Gun—Tool for discharging grease in definite limited quantities.

3—Grease Gun—Tool for discharging small increments of grease in definite limited quantities.

4—Grease Gun—Tool for applying grease to fittings requiring high pressure.

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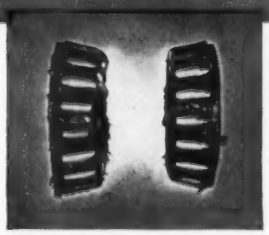

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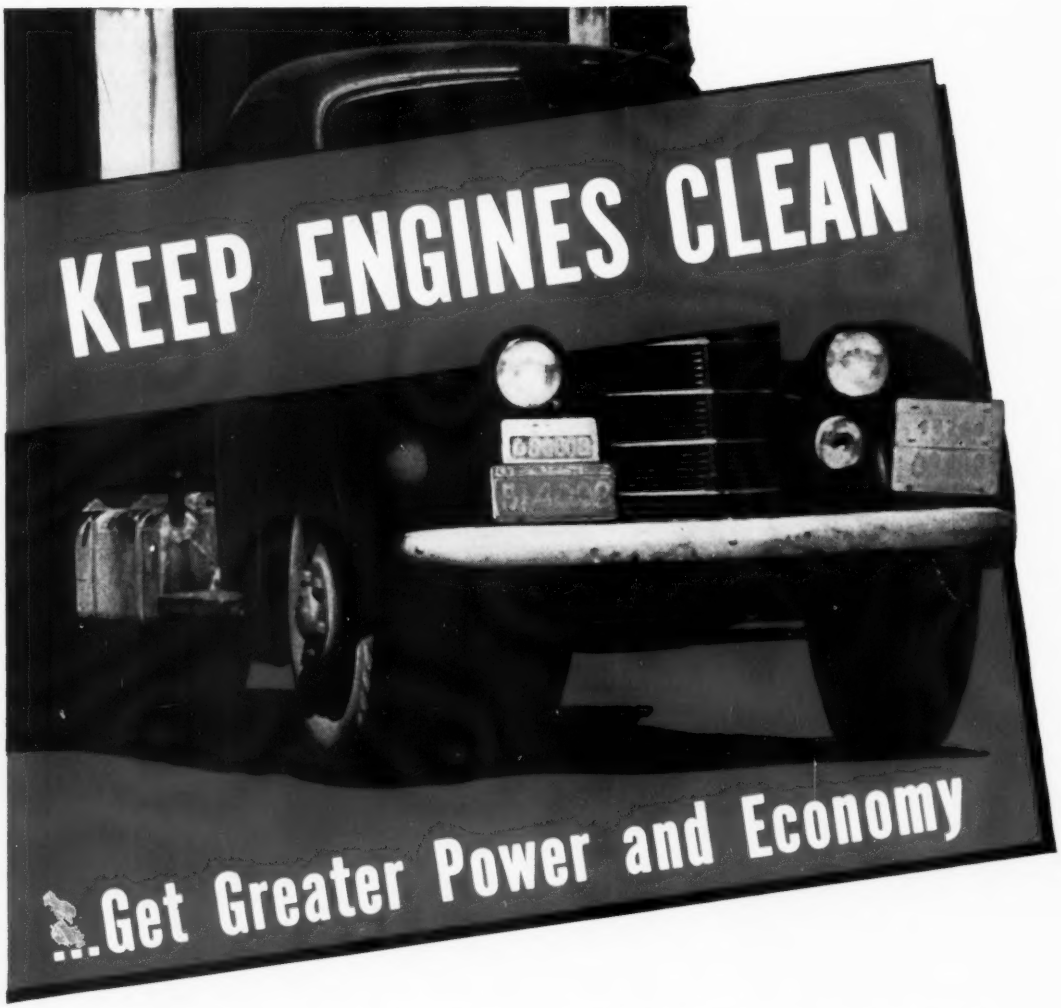

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